[0093] In a preferred mode, the following image processing is carried out by an image processor. Image processing carried out by the image processing unit is by no means limited to the following, and can include image processing typically carried out in the image processing field.

(1) Achieving high-quality stimulation by spatial edge extraction and by detecting specific edges and apexes.

(2) Achieving high-quality stimulation by carrying out extraction of specific colors.

(3) Achieving high-quality stimulation by extracting specific brightness.

(4) Achieving high-quality stimulation by specific time-varying pattern extraction.

(5) Achieving high-quality stimulation through recognition and extraction of specific images, particularly faces of people.

(6) Achieving high-quality stimulation by detecting time-varying movement.

(7) The effects of image variation due to a person moving their head are eliminated by eliminating movement of the image as a whole as an offset. In one mode, an angular acceleration sensor is used in order to eliminate the effects of image variation due to rotational movement of the head. In a further mode, an artificial retina chip having a movement detection function is used.

(8) In a further mode, movement of the image as a whole is eliminated as an offset and remaining time-varying variation is displayed in an enhanced manner. The motion parallax is then enhanced by translational movement of the head and is taken as a cue for depth.

[E] Method for Acquiring Image Information while Using an Image Sensor as a Sensor [E-1] Method for Presenting while Using a Wide-Angle Lens when Acquiring Images

[0094] The field of view is narrow so that it is necessary for the wearer to move their head frequently in order to obtain environment information for the whole of their surroundings. Further, because of narrower field of view, changes in the stimulation pattern represented as a result of movement of the head are acute and an unpleasant sensation is occurred. Further, supposing face to face communications between a visually impaired person wearing the present system and a healthy person, it is unconsciously assumed that both parties facing each other have a similar field of view. There is therefore the problem that it is difficult for the healthy person to communicate effectively with the person with impaired eyesight.

[0095] It is possible for the field of view to be made close to that of a healthy person (approximately 180 degrees when the pupil is not moved) by, for example, a wide-angle lens such as a fish-eye lens. If the field of view of the camera is made broader, the spatial resolution of the stimulation falls. However, a countermeasure is possible with respect to this problem where the ends of the image are compressed and representation takes place in the vicinity of the center at a high-resolution.

[E-2] Depth Detection and Presentation Using Focal Adjustment, a Compound Camera, and Measuring the Time-of-Flight

[0096] Information presented to the wearer can be narrowed down by detecting depth information during image acquisition. For example, it is possible to prevent stimulation due to objects that are far away such as, for example, buildings etc. by just taking objects up to a few meters away from the wearer as targets of presentation. This method is preferable from the point of view of the safety of the wearer and it is assumed that many of the visual sense-tactile sense conversion apparatus provided up to this point are capable of sensing depth. However, depth information acquisition proposed in the related art has not yet been implemented to a level that can be used in real life.

[0097] It was therefore necessary to confirm the characteristics of the usage of our system. Measurement precision is not important. It can be considered sufficient if objects within the range of a few meters can be measured with a precision in the order of 0.5 meters. The following two straightforward techniques are therefore candidates.

[0098] Firstly, focus of a lens is used, with this typically being referred to as a lens focal point technique. It is possible to blur out anything other than a certain depth by using the lens. Our system extracts edges from the image for conversion to stimulation. Therefore, the fact that images at unnecessary distances are obscured during the image acquisition provides very good compatibility with the present system.

[0099] Secondly, a simple method also exists where illuminating light is projected from a camera and the brightness of the reflected light is then taken as is as depth information. This has the problem of depending on the optical characteristics of the illuminated target surface but has the substantial advantage that a broad depth can be obtained in an extremely straightforward manner.

[0100] It is also possible for any of the depth detection techniques other than the foregoing that are already commonly in use to be employed for presenting sensations depending on distance. Typical examples would be firstly, taking three dimensional measurements using two or more cameras, and another would be measurements using TOF (Time-of-Flight). In particular, when a compound camera is used, the foregoing object, "broad field of view", is achieved at the same time. In this case, three-dimensional depth detection is possible only for regions where the fields of view of each camera overlap but it is not considered to be a problem. This is exactly the same as when a person does with two eyes and people carry out their daily lives without hindrance with a stereoscopic vision of a center view where the fields of vision for the two eyes overlap.

[0101] In the above, depth is detected based on optical image acquisition but it is also possible to use depth detection employing ultrasonic waves. In particular, currently, compactness of depth detection devices that comprehend space in three-dimensions by analyzing waves reflected back from objects using one or a number of sound sources and a matrix of a number of small microphones are becoming widespread and are portable. The spatial resolution of depth detection based on ultrasonic waves is low compared to depth detection based on light. Currently, depth data of a few hundred× a few hundred points is acquired based on optical images but only depth data of a few tens× a few tens of depth data can be acquired using ultrasonic waves. However, with our system, the final number of tactile presentation points is small and the depth detection based on ultrasonic waves is also sufficient. Further, when ultrasonic waves are used, there is the advantage that use in darkness is also possible.

[0102] Finally, sensations that depend on distance are presented. For example, stronger stimuli are presented for dis-